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Section of Anæsthetics.

February 5, 1915.

Dr. HAROLD LOW, President of the Section, in the Chair.

Anæsthetic Ether.

By HORACE FINNEMORE, B.Sc.Lond., F.I.C.

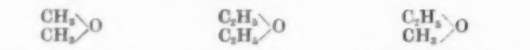
UNDER the term "ethers" are included those substances obtained from two molecules of an alcohol by the abstraction of one molecule of water. In their chemical relationship they are oxides of alcoholic radicles analogous to the oxides of the alkali metals, potassium, sodium, &c.—e.g., K_2O, Na_2O, R_2O, where R = (CH_3), (C_2H_5), (C_3H_7), &c.

The chief method of preparation consists in acting upon the alcohols with a dehydrating agent, such as strong sulphuric acid. This is heated to a temperature of 140° C. and the alcohol gradually and continuously run into it, while the ether that is formed distils over into a receiver.

The first view of the reaction was that it was a case of simple dehydration, but there is no doubt that this hardly expresses the complete view of the case. The action of the sulphuric acid is to form ethyl hydrogen sulphate, which, acting upon another molecule of alcohol, forms ether and regenerates the sulphuric acid. The reaction is, therefore, continuous, and a small quantity of sulphuric acid should suffice theoretically to convert a large amount of alcohol into ether, but in practice its action is limited by the occurrence of reduction and various side reactions, which gradually tend to bring the main reaction to an end, and necessitate the provision of fresh acid.

When a single alcohol, containing only one alcoholic radicle, such as methyl or ethyl alcohol, is employed as the source of ether, the product necessarily contains only one kind of radicle and is called a simple ether;

but if a mixture of two alcohols is used, not only are the corresponding two ethers formed, but there is formed a third ether, which, since it contains two radicles, is called a mixed ether. For example, while methyl and ethyl alcohol yield respectively only dimethyl and diethyl ether, a mixture of the two yields dimethyl ether, diethyl ether, and in addition the mixed ether, methyl-ethyl ether.



Dimethyl ether. Diethyl ether. Methyl-ethyl ether.

Dimethyl Ether.—The lowest member of the series, dimethyl ether or dimethyl oxide, is a gas boiling at −20° C. It is obtained from methyl alcohol by the general method outlined above. Some is formed whenever ether is made from mixtures of methyl and ethyl alcohols, and a little is therefore present in ether made from methylated spirit. It is largely used for the production of artificial cold.

Methyl-ethyl Ether.—The next member of the series contains another CH_2 and is the mixed ether, methyl-ethyl ether, mentioned above; this is formed from a mixture of methyl and ethyl alcohol. It is therefore formed, as we shall see later, when ether is made from methylated spirit, and it is found in unfractionated commercial methylated ether. Its boiling point is + 11° C.

Diethyl Ether.—The third member of the series is the most important as it constitutes the bulk of what we term anæsthetic ether. It is the only product where ethyl alcohol or rectified spirit is employed in the manufacture of ether. When pure it boils at 35° C. and has a specific gravity of 0.720.

It is said to have been discovered in 1542, by Valerius Cordus, but was possibly known before his time. It is not intended to enter into the historical question of who was the first to observe its anæsthetic properties. The theories of its formation from alcohol and sulphuric acid were formerly exceedingly vague. It was long considered to contain sulphur, which, if present, could only have been due to imperfect purification. Even to the present time, this view is reflected in the fact that it is often labelled and called "sulphuric ether" or "ether sulph."

As a class the ethers are volatile, inflammable, mobile liquids of low specific gravity. Although, chemically, they are fully saturated bodies, and are therefore stable and not very reactive, yet the presence of the oxygen atom, which under certain circumstances is capable of assuming

a quadrivalent character, renders them liable to form peroxides analogous to hydrogen peroxide. In fact, a well-defined addition product made from dimethyl ether is known.

Manufacture of Anæsthetic Ether.

Undoubtedly the best available source for the preparation of diethyl ether for all purposes is ethyl alcohol, which can be produced on a large scale in a tolerable state of purity, but the duty of over 20s. per gallon on this article prevents the economical production of ether from it. The only other source is that mixture of methyl and ethyl alcohols known as methylated spirit. The variety used is called industrial spirit. Its composition is 95 per cent. of alcohol and 5 per cent. of *wood* naphtha (methyl alcohol), and it differs from the ordinary methylated spirit sold to the public in containing no *mineral* naphtha. It can be distinguished from the latter variety by forming a clear mixture with water. As it contains the two alcohols mentioned above, it yields the three ethers—dimethyl, diethyl, and methyl-ethyl ether.

Owing to its cheaper cost, the ether made from the latter source has practically superseded ether made from rectified spirit. The requirements of a large general hospital, say of 600 beds, for anæsthetic ether amount approximately to one ton per annum, and since the latter variety costs approximately 25 per cent. of the former, we find that no large London general hospital uses ether made from rectified spirit, and figures have been published showing that a large proportion of anæsthetists in private practice also use the methylated variety. Moreover, the recent British Pharmacopœia, always well in the rear of actual practice, has now recognised industrial spirit as a source of ether.

Anæsthetic ethers comprise that made from rectified spirit and two main varieties obtained on a commercial scale from methylated spirit and sold for anæsthetic purposes. These are distinguished by their gravity and are:—

(1) *Ether meth., specific gravity 0.717*, prepared by washing.
(2) *Ether meth., specific gravity 0.720*, prepared by washing and fractionation.

(1) This variety represents the product obtained by the action of sulphuric acid on methylated spirit. Since it has only been washed and not fractionated, it contains all three possible ethers, and on that

account begins to boil at a very low temperature, the actual figures obtained in distilling 100 grm. being given in the following table. It will be seen that the sample possesses no definite boiling point. In distilling a sample, although iced water is running through the condenser, the vapour can be seen pouring out through the end of the condenser before any liquid distils over.

FRACTIONATION OF METHYLATED ETHER.

(1) *Low-boiling variety, specific gravity 0.717.*

First drop at 20° C.		Grammes
20·0°—25·0°	...	3·0
25·0°—29·5°	...	4·7
29·5°—31·0°	...	9·8
31·0°—32·0°	...	9·5
32·0°—32·7°	...	9·0
32·7°—33·4°	...	9·1
33·4°—33·9°	...	10·1
33·9°—34·0°	...	9·3
34·0°—34·2°	...	23·6
Residue	...	8·0
Loss	...	3·9
Total	...	100 0

The temperatures recorded in these tables have not been corrected for the influence of changes in the barometric height. They are therefore not comparable among themselves, but serve to show the range within which the particular sample distils.

This ether is the cheapest anæsthetic ether obtainable. It has been and is still used in some of the large London hospitals, and it is preferred by some anæsthetists. Theoretically it is a more volatile product than the next variety, although if the two are allowed to evaporate side by side in similar dishes the rate of evaporation does not vary more than 3 per cent. per hour. Provided it has been well washed it is not necessarily an inferior product, and the presence of the lower homologues is not deleterious from a chemical point of view.

(2) The second variety of methylated ether has not only been washed but it has been subjected to a very careful fractionation, whereby the lower boiling fractions have been eliminated. Provided the fractionation has been efficient, nearly all the dimethyl and methylethyl ethers have been got rid of, and the product corresponds very closely to the variety made from rectified spirit. The figures obtained by the fractionation of one of these and a sample of rectified ether are given in the following tables:—

(2) *Higher boiling variety, specific gravity 0.720.*

First drop at 33° C.		Grammes
33·0°—33·6°	... ...	2·8
33·6°—33·8°	... ...	7·8
33·8°	... ...	79·5
	Residue	8·0
	Loss	1·9
	Total	100·0

ETHER FROM RECTIFIED SPIRIT.

First drop at 34·4° C.		Grammes
34·4°—34·7°	... ...	50·6
34·7°—34·8°	... ...	40·8
	Residue	7·0
	Loss	1·6
	Total	100·0

PURE ETHER, FREE FROM ALCOHOL AND WATER.

First drop at 32° C.		Grammes
32·0°—34·0°	... ...	3·6
34·0°	... ...	86·2
	Residue	8·0
	Loss	2·2
	Total	100·0

Freshly made ether from rectified spirit is, as we have seen, practically composed of diethyl oxide with a trace of alcohol and water. Although it may be quite pure when freshly made, yet on standing it is just as likely to oxidise as methylated ether.

It may be pointed out in passing that ether of specific gravity 0.735, containing as it does large amounts of alcohol and water, and, as a rule imperfectly purified, is not intended for, and should not be used for, anæsthetic purposes.

IMPURITIES AND THEIR SIGNIFICANCE.

The impurities that may be present in commercial ethers are either those appertaining to the source from which the ether is derived, or they are those resulting from decomposition of the ether on keeping. Considering the former class we find that rectified spirit contributes alcohol and water, whereas methylated spirit in addition to these yields a small proportion of acetone. The impurities formed on keeping include peroxides, aldehydes, and acids.

It is necessary to state that, generally speaking, anæsthetic ether is a very well purified substance, and that the standards set each other by

the different manufacturers are high. The amount of these impurities present is exceedingly minute, although it will be understood that where large quantities are administered over a prolonged period, the effect of a very small percentage of irritating aldehydes, for example, may be appreciable.

Alcohol.

Although, strictly speaking, this can be considered an impurity, yet it is a beneficial one, for in some work on this subject by the late Dr. Wade and the writer we found that the more perfectly we freed ether from the alcohol which is always present in the commercial article the more prone to oxidation the ether became. This is quite analogous to what was already recognized with regard to chloroform; in both cases the alcohol acts as a retarding agent to the oxidising changes that the pure substance spontaneously undergoes. Fortunately, it is extremely difficult on a commercial scale to eliminate the last traces of alcohol, and it is undesirable that this should be done. In fact, the recognition of say 2 per cent. of alcohol in ether, as is official in the case of chloroform, would be a decided advantage.

Water.

Excess of water was formerly considered to be a disadvantage, and the last British Pharmacopœia defined a specific test for its presence by directing that no turbidity should be produced on admixture with carbon disulphide. I have had some ether containing water under observation for about ten months, and it seems distinctly to have acted as a preservative. The sample has been kept without any precautions as to light, &c., and the amount of peroxide present is quite negligible. This may either be due to the water as such, or it may have produced a little alcohol by hydrolysis, which, as we have just seen, acts as a preservative.

Acetone.

Acetone is a normal constituent of methylated spirit, and unless specially taken out is found in ether derived therefrom. On the other hand, acetone has never been found in ether made from rectified spirit. The amount is extremely small, being of the order of about 1 in 5,000. Its chief interest is a commercial one and lies in the fact that its presence is indicative of the source of the ether, being very strong

presumptive evidence of its manufacture from methylated spirit, although its absence is no evidence to the contrary, as some firms know how to remove it, and systematically take out the acetone from their methylated ether.

The writer has examined samples of ether sold to hospitals, stated to be made from rectified spirit, which were carefully fractionated methylated ethers, the character of which was suspected from the fact that they contained acetone, and the derivation of which from methylated spirit was confirmed by other methods.

Acetone may be tested for by adding about 1 c.c. of a freshly made 5 per cent. solution of sodium nitroprusside, and then 3 or 4 c.c. of a strong solution of ammonia, followed by solid ammonium chloride. An intense magenta colour quickly develops.

About half the methylated ethers on the market are free from acetone, and, as a rule, these are cleaner in other respects. Apparently the processes used to take out the acetone have also assisted in getting rid of the other impurities.

Peroxides.

These seem to be the first products of the decomposition of ether, and probably consist of hydrogen and ethyl peroxides. They are formed by the action of air and sunlight, hence the necessity of keeping ether as much as possible in the dark.

The test which was official in the last Pharmacopœia was capable of detecting $\frac{1}{4}$ mgr. of hydrogen peroxide in 20 c.c. of ether. This test was not stringent enough, not because this amount is dangerous, but an ether containing even such a small amount of hydrogen peroxide would also contain aldehydes in sufficient quantity to render it very irritating.

The new British Pharmacopœia employs a much more searching test in stating that no yellow colour should be developed within three hours when ether is kept in a completely filled white glass-stoppered bottle in the dark and frequently shaken, and although a freshly distilled ether may comply with it, yet the same ether kept for a month will most probably be found deficient. This test is of high degree of stringency and is comparable with one employed for some time, which consists in mixing the ether with a solution of vanadic acid; the green solution is changed in the presence of peroxides to varying shades of brown and red.

Aldehydes.

The chief of these is acetaldehyde, which is a liquid of a suffocating odour. Aldehydes are invariably present in ether that has begun to decompose, and their presence and amount are important factors in arriving at a decision as to the fitness or otherwise of a sample for anæsthetic purposes.

The new Pharmacopœial test for aldehydes consists in keeping the ether in contact with freshly broken potassium hydroxide in a bottle for an hour. This is not unduly stringent, as the samples that we have been accustomed to choose for anæsthetic purposes will remain uncoloured for at least six hours—the time specified in the German Pharmocopœia—and sometimes more.

It should not be forgotten that in a hospital where the ether is probably never kept for more than a month, it is possible to insist on a higher standard than would be feasible for inclusion in the British Pharmacopœia, where the tests have to be applied to samples which have been kept for a longer period, and have been carried to all parts of the world.

Acids.

These are formed by the further oxidation of acetaldehyde and other aldehydes. Acetic acid is the chief of these. They may be readily tested for, by noting the reaction of the residue left after spontaneous evaporation in a glass dish, or by shaking the ether with water and testing the solution with litmus.

Any acid reaction should immediately condemn an ether for anæsthetic purposes, because its presence is a sign that decomposition has taken place. Very few samples indeed give an acid reaction. One I remember was a sample sent to me from a special hospital where operations were infrequent. This had been bought and was labelled as ether made from rectified spirit. The anæsthetist noticed the peculiar odour and that it seemed "weak." The presence of acetone and its behaviour on fractionation showed that it had been made from methylated spirit; moreover, the fact that it was exceedingly acid showed that it had seriously decomposed, and this was borne out by the presence of much peroxide and aldehyde.

The Testing of Ether.

For a large institution the testing of ether resolves itself into a comparison of the results obtained by applying the foregoing tests to a series of 1-lb. samples obtained from all the leading manufacturers, and it is quite easy to arrange them in order of merit. The absolute amount of any impurity is not so important as its relative amount. There are generally some which give negative tests for the presence of all the known impurities.

Fractionation.

In order to be certain which variety of methylated ether is being supplied, and to distinguish between methylated and rectified ethers, it is necessary to submit the samples and bulk to fractionation. The evidence shows which of the three varieties is under consideration. A very efficient still-head must be employed.

Specific Gravity.

This alone gives very little information, because, taking an extreme case, an ether of specific gravity 0.717 can be increased to 0.720 by the addition of rectified spirit. It is necessary to point out the limits of this test because the specific gravity has been quoted as evidence of purity in a case of a patient dying under the influence of ether as an anæsthetic.

For anæsthetists who desire to obtain a rough idea of the ether they employ, the test with potassium iodide solution will be useful. Probably a more comprehensive test is one that I have employed for some years. It was first intended that it should be used as a test for vinyl alcohol, which is said to be present in commercial ethers. It was found to be unsuitable for this purpose, nevertheless it will quickly indicate freedom from decomposition products such as aldehyde and peroxides. It consists in adding to the ether a dilute solution of potassium permanganate containing 1 in 10,000, with 1 in 1,000 of sodium carbonate. Pure ether has no immediate action on this, very little change being observed in five minutes, but ether containing aldehyde or peroxides will quickly decolorise it, the rate of reduction being a very good index of the quality of the ether.

DISCUSSION.

Dr. DUDLEY BUXTON said that the members of the Section would welcome so useful a communication as the one Mr. Finnemore had presented. That gentleman's name was already well known to anæsthetists in connexion with valuable work done by him, in collaboration with the late Dr. Wade, on chloroform and ethyl chloride and published in the *Proceedings of the Chemical Society*. Mr. Finnemore had referred to the assumption of tetravalency by the oxygen molecule in the lower ethers, and on this point the speaker desired to ask whether that fact could explain the evolution of heat occurring when ether and chloroform were shaken together, as during the preparation of the A.C.E. and kindred mixtures. It was commonly stated that mere mixing, in contrast to chemical union, did not cause the molecular phenomena which gave rise to the evolution of heat. Was there any evidence that in these mixtures the union was more intimate than mere solution? The speaker believed that the evaporation of the ingredients was not that represented by their proportional values in their solutions.

The PRESIDENT (Dr. Harold Low) said he quite agreed that the best thanks of the Section should be given to the reader of the paper, for the subject was one of great interest to them as anæsthetists. It was extremely important that the purest of drugs should be used in their work. He (the President) thought that impure ether containing the deleterious compound acetaldehyde was not infrequently sold for anæsthetic purposes. He would like to ask whether it was possible to detect its presence by the smell. One point to which he might perhaps draw attention was the liability of ether to form peroxides in the presence of air and sunlight. He would therefore warn anæsthetists not to keep their ether in large half-filled bottles of clear glass.

Mr. C. J. LOOSELY pointed out that when chloroform and ether were mixed an effervescence took place as well as an evolution of heat, and that also in spite of this and the increased temperature there was a contraction of volume which could be demonstrated by inverting a drop-bottle immediately after shaking the mixture; bubbles would then be found to enter.

Mr. FINNEMORE, in replying to the discussion, stated that evolution of heat and contraction in volume were observed when other substances—e.g., alcohol and water—were mixed, and, as far as he knew, no claim had yet been made that chemical action occurred. In the case of chloroform and ether no evidence was yet available which showed definitely that chemical combination took place, although the evaporation of a mixture of the two was not uninfluenced by the presence of the other ingredient. In reply to the President's remarks, it was possible for a trained nose to detect the presence of aldehyde in ether.

A Discussion on the Methods of Induction of Anæsthesia.

Opened by HAROLD LOW, M.B.

LADIES AND GENTLEMEN,—As the paper we have just listened to was not likely to occupy the whole of our time this evening, I suggested at the last Council meeting of the Section that a discussion of the various methods in use for the induction of inhalation anæsthesia might be both useful and instructive. We, as specialists, I fear, suffer from the malady, I may call it, of isolation, which is so common among the members of our profession. Except at our own schools or hospitals we so seldom see one another at work. There is not that reciprocity of ideas which is so desirable in all scientific pursuit. Instead, therefore, of always listening to a paper on some new anæsthetic or new method, it is at times, I think, advisable to take stock, as it were. We are all liable to get too much into a groove. The best way I suggest to conduct this discussion is for each member present to state briefly the methods he or she employs and the reasons for doing so.

First, as to the induction of anæsthesia, I should like first to make a few general remarks. In the first place, it is immediately before and during the induction that the personality of the anæsthetist predominates. The knowledge as to how to deal with different temperaments at different ages is so important, as a patient about to undergo an operation is usually in an abnormal, nervous condition. To my mind, and I think you will agree with me, not only what method is used, but the manner of using it, makes all the difference, not only to the preliminary comfort of the patient, but also to the continuance of the anæsthesia as well as to the subsequent effects. In hospital work, perhaps, this side is too often neglected, especially in our teaching of the students. The soothing of the excited, the comforting of the nervous and frightened by a few gentle words, are so important.

Next, the various methods of inducing anæsthesia. From my own personal experience, which embraces more than twenty-five years, I have seen methods and ideas change. First, I remember when all patients except very old people and young children were smothered, I may say, by ether in a Clover's inhaler—the closed method without preliminary induction by nitrous oxide. A most unpleasant method. Next, the nitrous oxide and ether sequence was all the fashion—then various

so-called dosimetric inhalers were invented for chloroform—none were ideal and most a failure. Ethyl chloride and preparations such as somnoform were tried with more or less success. In recent years the closed method has been substituted, with a number of anæsthetists, by the open method. This method was used as a general practice first, I think, in America. Its simplicity is what appeals to me. Combined with a preliminary inhalation of a weak mixture of C.E., I cannot help thinking it is the method which will become general, and that the Clover's inhaler has had its day. I know I shall find a number of members not in agreement with me. As we have decided at this meeting not to discuss the preliminary use of narcotic drugs hypodermically, it is a little difficult to make good my case, as the two methods go so together. There is one more point, and that is the use of oxygen. Personally, I find great help from this gas and use it as a matter of routine from the commencement to the end of the administration. I think it is a great mistake to keep it simply for emergencies.

Dr. DUDLEY BUXTON: While in sympathy with much that has been said by the President, I cannot see eye to eye with him with regard to the use of the nitrous oxide and ether method. As the subject of the use of narcotics introduced hypodermically before inhalation has been ruled out by the Chairman, I will only say that their employment calls for a difference in the methods of induction, a difference of entire method, or a difference in the detail of method. I, personally, give atropine whenever I give ether, so that alkaloid becomes a definite part of my method. The alleged drawbacks to a gas and ether method are mostly or entirely eliminated by using atropine and by attention to detail. The prolongation of the induction period, except under unusual conditions and states—e.g., traumatic shock—is no gain, indeed, I believe the rapidity of the action of nitrous oxide is one of its greatest merits. Cyanosis, after-sickness, headache, and so on, are due mainly to partial asphyxia, and are in no way necessary in the method. Oxygen, which I have used for many years and with all anæsthetics, completely obviates such complications and lessens the venous bleeding, a trouble which many surgeons appear to regard as a necessary effect of the use of gas and ether. Whatever anæsthetic and method are selected for the maintenance of anæsthesia, the gas and ether plan is applicable. The open ether method so much in vogue, besides requiring a tediously prolonged induction, does not, as a rule, provide a level of deep narcosis, such, for example, as is called for in

dissecting operations and those on the abdominal viscera. It never allows more than a 12 per cent. vapour, and usually a 6 per cent. is alone obtained, whereas by a closed inhaler an ether atmosphere of 30 per cent. or 40 per cent. is possible. Thus it seems to me to be a great gain if, by using the gas and ether sequence, you can gradually pile up your ether strength during induction, the period when the intake should exceed the output, since you thus obtain a depth of narcosis which is competent for any operation and can be easily maintained at its level, even when an open method is pursued consecutive to the gas and ether sequence. I believe that the reaction in favour of an open ether method owes its origin to the misapprehension of the high strength vapour given by the closed method and to the old vicious teaching that induction by ether necessitated and was assisted by maintaining so great an air limitation as to produce cyanosis. These are errors in technique and are, of course, absent in the open method. However, they are not inherent in the closed method and will be avoided by those who understand the closed inhaler method. The views on acapnia advanced so vigorously by Professor Yandell Henderson, which indicate that a light narcosis—ineffectual rapid respiration—leads to a lowering of the content in blood of carbon dioxide, seem to me to indicate an additional merit in the gas and ether method for induction. While an open ether method tends to produce the condition said to lead to acapnia and fibrillation of the myocardium, the closed method certainly conserves the carbon dioxide in the blood and tissues and so protects the heart.

Time does not permit of details of methods being entered upon although it must be pointed out that such details require needful attention during the induction of anæsthesia when dealing with the many types of persons who require anæsthetics. Those who dread "gas" can, as a rule, be guided into the second degree of narcosis by inhaling chloroform from a regulating inhaler, such as the Vernon Harcourt. This could be followed by using a closed ether method, and then maintenance effected by the open ether system. With regard to this, I think it is very important that any mask used should be so made that a considerable space intervenes between its convexity and the face in order that one may breathe from an *atmosphere* of ether and air, rather than inhale the chilled ether vapour drawn by the inspiration directly from gauze forming the concavity of the mask. Also, excessive evaporation of ether away from the patient into the room should be prevented by covering the gauze with a layer of lint in which a hole is cut to receive the drops

of ether. I concur with the President that the anæsthetist should and could help the nervous patient by kindly treatment and by inspiring confidence. I habitually urge this on students whom I am teaching, and I remind them that whereas the administration of an anæsthetic is an episode to them, it is an epoch in the life of the patient, and inspires at once dread and loathing. The pre-anæsthetic storms of fear and struggling are apt to reproduce themselves during induction, and even in deeper narcosis, in the form of anarchical perturbations of respirations and changes in blood-pressure, and hence should, if possible, be carefully avoided or minimised.

Mr. Boyle: I prefer to induce anæsthesia with the gas-ether sequence, and use for that purpose a Clover's inhaler, with a small bag with gas tube attachment. I prefer this method because it shortens the period of induction, and I think that anything that can be done to shorten the induction period is a boon to the patient. Those who have had anæsthetics themselves will probably agree with me that during the induction period there is almost always a stage of mental excitement, which is little short of torture, and therefore I always try to make that period as short as possible. With regard to the suggestion that has been made that there is frequently a considerable amount of cyanosis attending induction by this method, I cannot agree, indeed, I hold and have taught for some time that cyanosis is nearly always due to faulty administration and faulty technique. No doubt there are many who will not like to admit this, but, nevertheless, I believe it to be true.

Section of Anæsthetics.

March 5, 1915.

Dr. HAROLD LOW, President of the Section, in the Chair.

Discussion on the Influence of Preliminary Narcotics on (*a*) Induction, (*b*) Maintenance, (*c*) After-results of Anæsthesia.

Opened by J. BLUMFELD, M.D.

ABOUT four years ago this Section held a discussion on very similar lines to those laid down for this evening. On that occasion the opinions expressed were at the same time very various and very emphatic. There were those who, enthusiastic for the novel procedure, would lead one to imagine that with the use of morphia and scopolamine, followed by open ether, the ideal in anæsthesia had been achieved. They claimed the perfectly quiet induction, absolute relaxation and complete freedom from after-effects which we are accustomed to see claimed for every innovation in anæsthetic practice. There were others, equally strenuous on the other side, who maintained that increased excitement and prolonged rigidity were the main phenomena they had witnessed in connexion with the use of preliminary narcotics. These opinions were in neither case the result of prolonged experience, and I think that to-night's discussion will probably show a juster view and will prove that, as is so often the case, the first impressions were of too wholesale a character, and that the truth is ascertained when we have been able, by long use, to exercise discrimination, and to declare that there are cases where this method is of the greatest value, and others where it should not be employed. This brings me to the first point which I wish to raise—viz., the routine

use of preliminary narcotics. My own view with regard to this is that we should not employ any of these drugs as a routine except atropine. So far I have neither met with, nor heard of, any ill-effects from the preliminary use of atropine, and therefore I think we are justified in using this in a routine manner. We must remember that a routine use of preliminary drugs before anæsthesia involves us in the proceeding of prescribing the drug for a patient whom we have not seen. This does not seem to me a reasonable course of action in the case of such drugs as scopolamine and morphia, and I believe, therefore, we should use these only if we have the opportunity of either seeing the patient beforehand, or at least of satisfying ourselves that there is every probability of the drugs not upsetting him. Also, it must be certain that he will not have to walk or to be disturbed after the hypodermic injection and before the operation.

It is in hospital practice particularly that there appears to me to be objection to the routine use of these drugs, because it often happens that the experienced anæsthetist, who was expected, does not actually give the anæsthetic, and the administration falls to the lot of a junior man who has had no experience with the conditions brought about by preliminary injection, and who would not have had one given had he known he was to be the anæsthetist. These remarks do not apply to atropine, and the routine use of this drug has the great advantage that it renders convenient the free use of open ether, when without it there would be in many cases much trouble from secretion of mucus and saliva. Another point against the routine use of morphia and scopolamine is this, that the case may turn out to be one in which chloroform should be given to a deep degree of narcosis, and that is not a method of anæsthesia to be safely practised after the preliminary use of these narcotics. A recent American writer states that he considers preliminary medication an essential whatever anæsthetic is used for patients between the ages of 19 and 50. This is, to my mind, a sweeping statement, only to be accepted with the reservations that I have indicated. Let us look for a moment at the advantages which we may expect to derive from preliminary narcotics. They are, I think, these: First, a quiet induction, begun with the patient in a state of drowsy indifference, if not already asleep; secondly, a diminished consumption of the anæsthetic during anæsthesia and a diminished chance of surgical shock; and thirdly, diminution or absence of all deleterious after-effects. Now atropine, for which alone I recommend routine use, plays a large part in securing the second and third of these advantages,

though it helps but very occasionally, if ever, towards the first. Scopolamine alone, or scopolamine and morphia, are much more potent in quieting a patient beforehand, and in the case of frightened or highly nervous individuals they give great help. Yet there are cases in which these drugs do the very opposite of what is hoped for from them, and cause a condition of excitement or of nausea; that is another reason why I do not like to use them unless I can see the patient beforehand, and have at least a chance of judging whether the narcotics will be helpful or the opposite. Again, these drugs, in my opinion, prolong the induction of anæsthesia, and particularly prolong the time necessary to obtain complete muscular relaxation. It may be that this is owing to their effect in lowering the respiratory extent and activity, and indeed the delay has sometimes seemed to be abolished by the concurrent use of oxygen. With regard to after-effects, the balance of evidence is in favour of good results from scopolamine, with or without morphia. The unconsciousness is, of course, much prolonged, and during this time the anæsthetic is being eliminated. When consciousness revives there is sometimes as much sickness, though starting later, as if no narcotic had been employed; more often, however, the sickness does not occur, or is but slight.

The kind of cases for which I prefer to use morphia and scopolamine, or omnopon alone in addition to atropine, are these: First, highly nervous individuals who are afraid of taking an anæsthetic, and also insane persons; secondly, all protracted nose and throat cases; thirdly, in the case of all very muscular, plethoric, or alcoholic individuals, even though the operation is to be a short one. I value these drugs in the nose and throat cases because of the ability they afford us to keep the patient conveniently quiet during a light degree of narcosis, with unabolished coughing reflexes. In the difficult muscular and alcoholic subject they enable us to maintain an open ether anæsthesia, impossible without their aid.

Sir FREDERIC HEWITT: I have a high opinion of the use of preliminary narcotics, provided care and discretion be exercised. It is to be regretted that the anæsthetist is not, as a rule, able to see his patient some time before the operation. Whenever practicable, however, such a course should always be adopted. By careful inquiry as to the patient's susceptibility to narcotics and by the use, in certain special cases, of a trial administration a day or two before the operation, the anæsthetist is generally able to secure good results. I have taken

careful notes of 266 cases—principally abdominal—in which I have employed preliminary narcotics, sometimes using morphine and atropine, $\frac{1}{6}$ gr. to $\frac{1}{4}$ gr. of morphine and $\frac{1}{150}$ gr. to $\frac{1}{120}$ gr. of atropine, and sometimes morphine, scopolamine and atropine in the respective doses of $\frac{1}{6}$ gr., $\frac{1}{100}$ gr. and $\frac{1}{120}$ gr. I have endeavoured, whenever possible, to compare the effects of different procedures upon the same patient. There is no doubt in my mind as to the general advantages of the plan, not only in regard to the patient's comfort before and after the anæsthetic, but in regard to the absence of excitement and muscular rigidity. Atropine is very valuable in that it prevents nasal and oral secretions, and thus very materially lessens after-vomiting. I have obtained the most complete abdominal relaxation with morphine and atropine, followed by open ether freely administered orally, not nasally.

I have of late become rather shy of scopolamine except in cases in which definite pre-anæsthetic stupor seems indicated. I have met with one case of distinct scopolamine idiosyncrasy. The patient, an elderly man who had lived well, was profoundly narcotised by $\frac{1}{100}$ gr. scopolamine; the anæsthetic was given while he was in this condition; there was most inconvenient rigidity during the operation of prostatectomy, and during recovery there was so much excitement that assistance had to be obtained. I have also published one very remarkable case of morphine idiosyncrasy. I have never seen any contra-indications to the use of atropine.

On the whole, I am inclined to use morphine ($\frac{1}{4}$ gr. for adult males, $\frac{1}{6}$ gr. for women, with $\frac{1}{150}$ gr. of atropine) before practically every operation, provided there are no contra-indications. I prefer freshly prepared solutions to "tabloids," and it is important that the needle should enter the subcutaneous tissue. I generally have the injection given three-quarters of an hour beforehand. There are, however, in my judgment, certain cases in which morphia is strongly contra-indicated. It should not be given to patients suffering from any respiratory difficulties. It is, moreover, in my opinion, strongly contra-indicated in all throat, nose, and mouth operations liable to be attended by hæmorrhage, unless indeed a light, and therefore an inconvenient, anæsthesia be maintained. I have known two or three fatalities—one after excision of the tongue and one after excision of a laryngeal growth —which were, in my opinion, partly, if not chiefly, due to pneumonia excited by the passage of blood into bronchi rendered insensitive by morphine. The profession has not, I think, fully realised the import-

ance of a rapid return of the coughing and swallowing reflexes after operations of this character. There is also another class of case in which morphine is probably very prejudicial; but here I feel I am invading the province of the surgeon, for I refer to the risks of giving morphine *after* abdominal operations. When these operations have been conducted under mixed narcosis I think that special care is needed lest an additional dose of morphine paralyse intestinal action. There seem to be certain cases of enterectomy in which the bowel very tardily regains peristalsis, and it therefore seems clear that great caution is needed before repeating morphine used as a preliminary to anæsthesia. As to the behaviour of morphinised patients under anæsthetics, I agree that the sleep-like breathing may sometimes prolong the administration. I should like, however, to state very definitely that I do not remember any case in which marked slowing of breathing has taken place during full anæsthesia. Certainly such cases are very rare with morphine, though they may be more common with scopolamine. For highly nervous, apprehensive, excitable subjects I consider the use of appropriate preliminary narcotics almost essential to success.

Dr. TATE: I am strongly in favour of the preliminary use of narcotics prior to anæsthesia. I am in the habit of using morphia, atropine and hyoscine, or morphine and atropine alone. It is necessary to exercise some care and judgment in the use of hyoscine, which is not advisable in the case of old and feeble patients. The use of these preliminary drugs may be considered from the point of view of the surgeon and of the patient. It has been stated as an objection to their use that complete relaxation of the abdominal muscles is not always obtained. So far as my experience goes, which embraces operations chiefly over the lower area of the abdomen, I have not found any difficulty in obtaining satisfactory relaxation of the abdominal walls. There are many advantages from the patient's standpoint. In many cases the patient's senses are partly dulled, and in some cases they are entirely freed from all the painful dread and nervous tension of the hour preceding the operation. The amount of anæsthetic required during the operation, after a preliminary narcosis, is materially diminished, and sickness after operation is reduced to such an extent that it is quite an exception for any troublesome sickness to occur at all. As a rule, the patients pass into a comfortable quiet sleep after being put back to bed and remain in this state for some hours. In some cases, when they become entirely

conscious they have no recollection of any incidents in connexion with the operation, which is an enormous advantage in the case of nervous patients.

Miss TURNBULL: There are two points on which I should like to express my agreement with Dr. Blumfeld: (1) I have found the preliminary use of atropine alone very satisfactory; (2) I agree that the preliminary injection of atropine and morphine before operations on the nasal passages is of great value.

Dr. MENNELL: I have practically nothing to add to what Dr. Blumfeld has said, and I am in complete agreement with his conclusions. Dr. Tate is to be congratulated on the results he has obtained, but he is fortunate in having only cases involving the lower abdomen, and further, his theatre is immediately outside the ward, so that it is especially easy to control patients after injection of the narcotic and before the anæsthetic is given. It must, I think, be generally allowed that scopolamine sometimes causes difficulty in high abdominal cases when complete relaxation is a necessity, and the majority of anæsthetists must have met surgeons who refer to a rigid abdomen under an anæsthetic as the "scopolamine belly."

Mr. BOYLE: There is very little to add to what has been so ably expressed by Dr. Blumfeld, Sir Frederic Hewitt, and the other speakers, and there is one point that I think this discussion has emphasised, and made clear, and that is that we as anæsthetists ought to see our patients a day or so before the operation. It is obviously wrong to prescribe a routine dose of any narcotic or mixture of narcotics without first seeing the patient, so that we can determine whether a narcotic is desirable or not, and if it is desirable, to decide what drug or drugs, and what dose is most suited to the case in hand. Moreover, if we have seen the patient before the operation—and I speak now especially of nervous patients—we can to some extent calm their fears; and even if we do nothing else we have seen each other, and on the morning of the operation the anæsthetist is not another strange person to be encountered. It is an important point, and one that I wish the surgeons would consider.

I have recently at No. 1 Base Hospital, to which I am attached, been giving a fairly strong dose of a narcotic mixture to the soldiers one hour before the operation; I think that by giving it one hour before

one probably obtains the maximum effect. The dose I have been giving is morphia $\frac{1}{6}$ gr., atropine $\frac{1}{100}$ gr., scopolamine $\frac{1}{100}$ gr., and I have made careful inquiries from the sisters as to results. There is no doubt in my mind as to the benefit obtained with regard to the quietness of the induction period. Before this injection was given the men, although fairly quiet at the start of induction, almost invariably struggled and fought; and my experience goes to show that beneath this outward calm they one and all are nervous, and fight when losing consciousness. But now all this is changed; they come up in a drowsy condition, they are anæsthetised quietly, they return to the ward, and recover quickly and quietly. There is, however, one great drawback which has been complained of, and that is the intense thirst and dryness of the mouth both before and after the operation, but with this exception the condition of the men, before and after, has been most satisfactory.

Dr. G. A. H. Barton: I think the Council are to be congratulated on their choice of a subject for discussion to-night, which is one of considerable general interest. I only wish to dwell on a few points that have impressed themselves upon me as a result of my practice in the last three years, during which I have practically adopted the administration of narcotics previous to anæsthetisation as a routine method. I have used morphia, scopolamine, and atropine alone, or in various combinations, Riedel's scopomorphine, omnopon, and omnopon-scopolamine.

Owing to the depressing influence of narcotics on the respiratory centre, induction is slower than usual where the agents used are chloroform or ether, alone, or in combination; but where, as almost invariably rules in my practice, ethyl chloride is used in addition, its stimulating effect on respiration becomes obvious and the patient quickly goes under. Struggling, of course, is, as a rule, much less marked and very transitory.

With regard to the type of anæsthesia developed, I think the best results are to be obtained by a full dose of morphia and scopolamine, say $\frac{1}{4}$ gr. and $\frac{1}{100}$ gr. as a routine, with an extra amount of morphia for big and strong men: soldiers, I may say, seem especially to need big dosage. Thereafter my object has been to keep the patient in a condition of light anæsthetic sleep by means of the minimal dosage of open ether necessary for the purpose. It is astonishing how little is required in many cases. I always like to keep a brisk corneal reflex; some movements are not infrequently present. Once they are accustomed to

it, surgeons invariably appreciate this form of narcosis, and they soon realise its advantages. Shock practically never occurs. Whilst I am by no means a convert to Professor Crile's theory of shock, nor to the *details* of his method of anoci-association, I am a believer in the *principle* of the method, and am convinced that in the judicious combination of alkaloids and open ether we arrive at the best means of carrying out these principles.

The use of narcotics enables us in nearly all cases to maintain the anæsthesia with open ether. I have never deliberately set myself to follow them up with chloroform and consider that a practice to be deprecated. For a long time we have appreciated the dangers of overdosage, and lately, thanks to Dr. Goodman Levy,[1] we have learnt something of the dangers of under-dosage of chloroform. Again, chloroform lowers blood-pressure and conduces to shock and post-operative complications.

Another advantage of the use of alkaloids and open ether is to be seen in the after-condition of the patient. If he has had previous experience of other methods he will, at any rate, appreciate this one. He generally sleeps comfortably for some time after the operation, and as a rule wakes up feeling none the worse for the experience, being rarely troubled with vomiting or other post-anæsthetic discomforts. Of course, one occasionally comes across patients who are upset by morphia. Speaking generally, I have found morphia vomiting more common in adolescents. Again, one occasionally meets with a type in which scopolamine appears to set up a great deal of excitement. There is no doubt that patients recovering from this narcosis require a little more careful watching than others.

Dr. SHIPWAY: I am entirely in favour of the principle of giving narcotics before operation whenever possible. This is a real kindness to the patient and of much assistance to the anæsthetist. Morphine and atropine can be given in the majority of cases, but for very nervous patients scopolamine should be added, although it has the disadvantage that it sometimes makes induction slow and delays the attainment of relaxation in operations upon the upper abdomen. I am in favour of using small doses of morphine combined with atropine in mouth, nose and throat operations. As regards after-results, the preliminary injection of narcotics undoubtedly ensures a better recovery. I do not think, from careful inquiries, that flatulence is increased. There

[1] *Proceedings*, 1914, vii, pp. 57-84.

are, of course, some cases of idiosyncrasy to morphine; if this condition in the patient is known beforehand chloretone may be substituted, often with advantage. I have found it useful in some patients who have on previous occasions been much troubled with vomiting.

The PRESIDENT in closing the discussion, said: The present discussion has been, I think, useful and complementary to that of the last meeting of the Section, "On the Methods of Induction of Anæsthesia." When the subject of the use of narcotic drugs as a preliminary to anæsthesia was brought before the Section several years ago but few of the members had had any extensive experience of their effect. Now most of us are able to give an expert opinion as to the advisability of using them. I quite agree with the opener of the discussion that as regards such drugs as morphia, scopolamine, omnopon, &c., their routine use in hospital practice is not advisable. In unskilled hands they are not free from risk. It is often impossible, in hospital practice, to say who may have to administer the anæsthetic in any individual case; and house officers vary so in their knowledge of the subject, that whereas these drugs are safe in one man's hands, they are not in another's. At St. Thomas's Hospital, a rule has been made that no narcotic drugs are to be used by the resident staff. The danger that may arise from their use especially applies to chloroform. And I go so far as to say that deep chloroform anæsthesia should never be induced subsequent to their administration. As to the use of atropine by itself, I do not think the foregoing remarks apply; as I have never seen any ill-effects from its use, and its property of arresting the mucous secretions may produce a beneficial effect. In private practice I make a point of either seeing the patient beforehand or communicating with the surgeon or doctor in charge of the case before ordering the administration of morphia and such-like narcotics. On the other hand, when a skilled anæsthetist is going to administer the anæsthetic, and in selected cases, I am firmly convinced a preliminary injection of a small dose of morphia and atropine is highly desirable. As to the use of scopolamine I am not so certain. Its action is often not to be depended upon, and I have seen several cases in which definite toxic symptoms have supervened.

On the agenda the discussion has been divided into three parts, the induction, maintenance, and after-effects. Personally, at all these times I think good may arise from the use of morphia and atropine. First, in the pre-induction stage, the patient, who is often in a highly nervous

condition, is soothed either to sleep or to a state of quietude. Among the military patients, of whom I have lately had so much experience, this has been most marked, and many a poor soldier has been completely oblivious of the fact that an anæsthetic has been administered to him. How great a gain is this. Next as to the maintenance: I am sure that less anæsthetic is required throughout the operation. I cannot help thinking that those speakers who have laid stress on the rigidity following the use of scopolamine have forgotten the fact that the anæsthesia is lighter than in cases where no narcotic has been previously used. Thirdly, as to after-effects, I quite agree with Dr. Tate in his remarks that post-anæsthetic sickness is rare after the use of these drugs.

In conclusion, I may say that should it be my fate to have to undergo an operation I trust I may be given an injection of morphia and atropine beforehand.

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